

One Lesson from TARET: what is expected from a remote lab?

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Abstract—During the last TARET Summer School in Maribor-Villach 25 students and 6 teachers answered a survey about what characteristics of a remote lab are preferred by them. The results and analysis of the results are given in the work.

Index Terms—Remote labs

I. INTRODUCTION

TARET stands for TraininAdvanced Remote Technologies and is a three years Intensive Project (2007-2009) in the Lifelong Learning Programme. The main task of the project TARET was to provide three winter and summer schools to train students and teachers in several fields of "Remote engineering". The project was planned as an integrated part of the ERASMUS Curriculum Design project MARE (European Master in Remote Technologies) and united students and teachers from six European countries (Austria, Germany, Romania, Slovenia, Spain and Sweden) studying and working in the unique "Remote Engineering" study program in Europe in several intensive on-site phases together. The last summer school 2009 in Maribor and Villach was dedicated to several remote solutions in a wide area of engineering subjects.

Online or remote engineering is a current trend in engineering (and science), aiming to allow and organize a shared use of equipment and resources, but also specialized software over a network, as usual internet. Virtual and remote laboratories and workplaces are one of the main applications and future directions for advanced teleworking/e-working environments especially in engineering and science but also in other fields of the society. This also would benefit people with special needs and people working from their home.

But there is a lack of specialists in this field to develop and maintain such remote engineering solutions and the number of needed specialists will dramatically increase in the next years.

The general objective of the intensive programme was to provide a winter-school in "Telerobotics" (Villach, 2007) and summer schools in "Mobile&Wireless Techniques" (Ilmenau, 2008) and "Remote Applications" (Maribor/Villach 2009) as a part of the MARE curriculum. The goal was to mediate fundamentals, applications and experiences in these fields of remote

engineering by an interdisciplinary approach in combination with "learning by doing" phases. In this way it promoted transnational cooperation and exchanges between students and teachers of the participating universities, encourage efficient and multinational teaching of special topics, which could not be taught in this quality in the home universities.

Also it enabled students and teachers to work together in multinational groups, so as it will be normal in international development and working teams in remote engineering. The intensive programmes are a combination of theory and practical teaching, which is necessary for the technology enhances teaching mode of MARE and gave the students and teachers new perspectives in the topics being studied, using the scientific, didactic and practical experience of the scientists in the host universities and the unique lab possibilities of these institutions.

The intensive programme was open and also students from the universities in Porto, and universities of technology in Kiev and Kharkov participated, it required at least a bachelor degree in engineering, science or informatics and some prerequisites in remote engineering.

In the last summer school 2009 students were introduced to several remote laboratory solutions from the universities and institutes of technology in Maribor, Blekinge, Carinthia (Villach), Deusto (Bilbao), Düsseldorf, Ilmenau and Brasov, but they also investigated and analyzed. [1]. The results an survey analysis of these remote labs is presented in this paper.

II. THE SURVEY

Usually the design of remote labs is made by teachers, and they used to establish the requirements of the remote labs without knowing the opinion of the final users: the students. Of course teachers are also users of remote labs, because they use them in their subjects, but they do not have to forget the students' opinion.

Furthermore the teachers/designers are more concerned with hardware than with software, and by using this approach the remote labs designed are not good from a software engineering point of view. But referring [2] and remembering that a remote lab is client-server application, some requirements can only be obtained by using some technologies. So first it is important to know the requirements expected by the users/students and by the teachers/designers and then a technology should be chosen to implement the remote lab with the requirements.

In the TARET summer school were involved teachers and students from different countries, so it was a good opportunity to ask them about the preferred characteristics of a remote lab. At the end of the Session "Remote Labs Characteristics", the students received a survey with 10 characteristics of a remote lab (they are described below), after reading the description they had to order the characteristics writing 1 in the most important, 2 in the second, and so on; the least important characteristic was assigned to 10.

The second part of the task for the students was to give the survey to the teachers of TARET to ask them to fill it in the same way.

After this process 31 surveys were filled, 25 by the students and 6 by the teachers. The objective of the work is to find the most important characteristics from each point of view (students and teachers) and to analyze if the results were the same in the both groups.

Below you can read the document that was given to the students and teachers.

I ask you to complete the next table. In this table I have written some characteristics of a remote lab with a word and a sentence to explain each characteristic. What I need are you to write in each characteristic a number from 1 to 10. Please write "1" in the most important characteristic from your point of view in your remote lab (or in general), after a "2" in second most valuable characteristic, and finally a "10" in the least important. Please do not repeat any number. I think that it will take you only five minutes, and for me it will be very interesting.

a. Cross-platform

The Weblab can be accessed by **all** the O.S.: Windows, Linux, Mac OS, etc.

b. Web Browsers

The WebLab can be accessed by **all** the web browsers: Explorer, Mozilla, Opera, Safari, etc.

c. Intrusivity

The user **has not to click in any plug-in** to give permissions to the client application: hard disk access, execution of native code, etc.

d. Security /Firewalls

The WebLab is secure in its design. It uses **https**, does not need permissions on the **firewalls**, only needs the **80 & 443 ports** open.

e. Devices

The WebLab can be accessed by **all** the devices: PC, PDA, mobile phone, etc.

f. Installation

The WebLab runs **without** any previous installation in the client side: plug-in, JVM, Flash Player, etc.

g. Audio & video

The WebLab needs the **maximum** of audio & video power.

h. Interaction

The WebLab needs to implement the **maximum** of interaction with the user.

i. Bandwidth

The WebLab needs the **maximum** bandwidth performance.

j. Power

The WebLab is **very complex** and needs a powerful tool to implement it.

Characteristic	Number	Characteristic	Number
Cross platforms		Installation	
Web browsers		Audio&Video	
Intrusivity		Interaction	
Security/Firewalls		Bandwidth	
Devices		Power	

According to Tables I-III and Fig. 1-2 some comments can be made, but each reader can analyze the results:

- All teachers asked are related with remote labs (research, design, use, etc.) but the majority of the students are not.
- More or less the two groups have the same opinion. The students and the teachers prefer universality and security to power in general terms.
- Cross platform and web browser are the most valued characteristics for the students. It sounds perfect because some students use windows, other Linux; Mozilla, Safari, etc. They do not want to change their "computers" and they do not want to accept something like "you have to use Windows and Explorer to access the remote lab".
- Installation, Intrusivity and Security are the second group for teachers and students, but there are some differences.
- For the teachers, security in general terms is very important because they are designers and if they want to open ports, modify firewalls, give permissions etc., they will have serious problems with the IT services of their universities. So they like to design/use remote labs without problems with security. But this approach is not the same for the students because they are users and they are their own IT services.
- The last group: Devices, Audio&Video, Interaction, Power and Bandwidth are not very much appreciated by the students and teachers, but there are also some differences.

TABLE I. RESULTS OF THE SURVEY FILLED BY THE STUDENTS

student n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	tot
Cross platform	1	1	2	1	2	1	1	1	1	1	1	1	1	1	3	1	2	5	3	2	5	4	1	2	1	45
Web browsers	3	3	1	3	4	2	2	7	3	4	4	4	3	3	1	2	1	6	2	1	6	5	2	1	2	75
Intrusivity	5	9	5	5	1	4	4	6	6	6	5	5	5	2	2	6	6	7	9	3	4	8	5	3	5	126
Security	6	6	9	6	3	6	5	5	8	10	3	3	6	5	4	4	3	9	1	4	3	7	9	4	6	135
Devices	9	2	8	4	5	3	3	2	7	8	10	10	10	9	9	8	5	1	8	6	1	10	3	7	7	155
Installation	2	4	10	2	6	5	6	4	2	2	2	2	2	4	7	3	8	3	5	5	2	6	4	8	8	112
Audio & Video	7	8	7	7	8	7	10	8	5	9	8	8	7	8	10	9	9	4	7	10	10	9	8	9	4	196
Interaction	4	5	4	9	10	8	7	3	4	5	9	9	4	6	5	5	4	8	4	8	8	1	7	6	3	146
Bandwidth	8	7	3	10	9	9	8	9	9	3	6	7	9	7	6	7	7	2	6	9	9	3	6	5	9	173
Power	10	10	6	8	7	10	9	10	10	7	7	6	8	10	8	10	10	10	10	7	7	2	10	10	10	212

TABLE II. RESULTS OF THE SURVEY FILLED BY THE STUDENTS

teacher n°	1	2	3	4	5	6	tot
Cross-platform	4	1	2	3	1	9	20
Web browsers	5	4	3	5	7	1	25
Intrusivity	1	5	4	1	4	5	20
Security	2	2	1	2	5	10	22
Devices	6	8	9	9	8	8	48
Installation	3	6	8	4	3	3	27
Audio&Video	8	10	6	8	2	4	38
Interaction	7	7	10	10	6	6	46
Bandwidth	9	3	5	6	9	2	34
Power	10	9	7	7	10	7	50

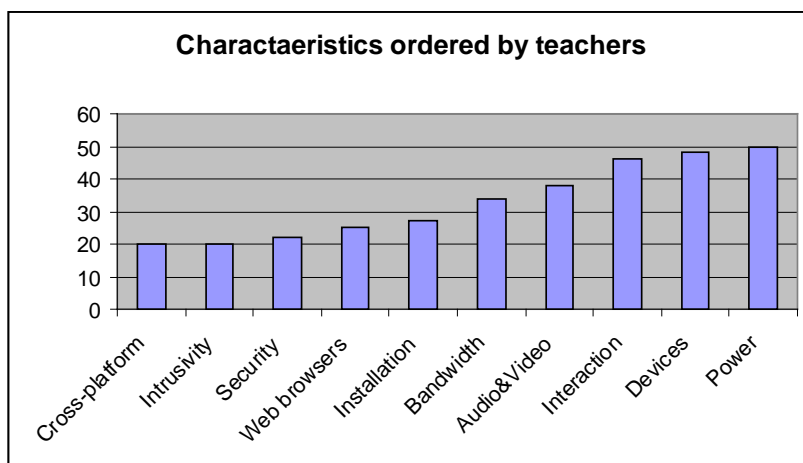


Figure 1: Characteristics ordered from the teachers' point of view

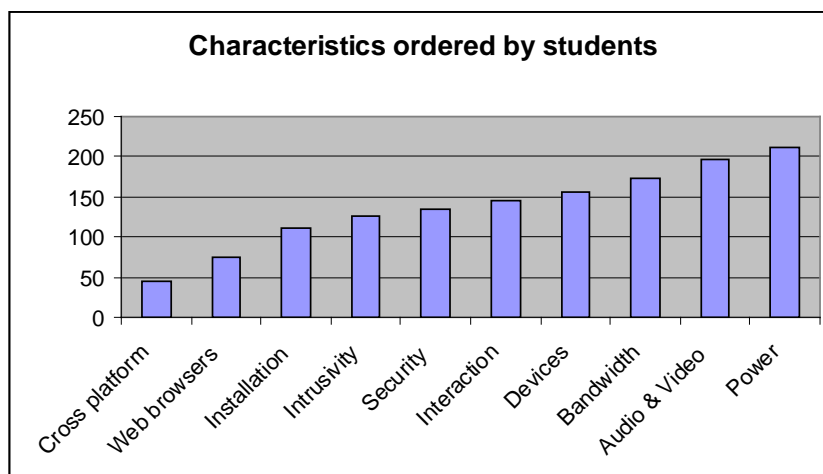


Figure 2: Characteristics ordered from the students' point of view

- The teachers, as remote labs designers, know that there are problems with the quality of video related to bandwidth.
- The student wants to interact in a high level with the remote lab; he wants to have the control of the experiment.

TABLE III. CHARACTERISTICS ORDERED BY THE TEACHERS AND THE STUDENTS

Charac. Teacher	Number	Charac. Student
Cross platform (20)	1	Cross platform (45)
Intrusivity (20)	2	Web browser (75)
Security (22)	3	Installation (112)
Web browsers (25)	4	Intrusivity (126)
Installation (27)	5	Security (135)
Bandwidth (34)	6	Interaction (146)
Audio&Video (38)	7	Devices (155)
Interaction (46)	8	Bandwidth (173)
Devices (48)	9	Audio&Video (196)
Power (50)	10	Power (212)

Table IV describes how many students/teachers include each characteristic among the five more important characteristics. Some comments can be added to the ones mentioned above between the results of the teachers and the students:

- Cross platform, Web browsers, Installation and Power are valued in the same way by students and teachers.
- Audio&Video and Bandwidth are more important for teachers (33%) than for students (15-20%), as it has been said before.
- Security and Intrusivity are more important for the teachers (90%) than for the students (60%), as it has been said before.
- 50% of the students want to have a good interaction with the remote lab, but none of the teachers says the same. Designers and users have a different point of view in a central issue of a web application.
- 36% of the students like to connect the remote lab through different devices like mobile phones, but none of the teachers like this. It is clear that the students are more “connected”.

TABLE IV. % OF ACCEPTATION OF THE CHARACTERISTICS BY STUDENTS AND TEACHERS

	students	teachers
Cross platform	100%	83%
Web browsers	92%	83%
Intrusivity	64%	100%
Security	60%	83%
Devices	36%	0%
Installation	68%	66%
Audio & Video	12%	33%
Interaction	50%	0%
Bandwidth	20%	33%
Power	4%	0%

III. CONCLUSIONS AND FUTURE WORK

The most preferred characteristic of a remote lab is its universality, more than the power in general terms. This

conclusion is shared by the students and the teachers asked. The design of remote labs should take into account this conclusion, or at least they should make the same study of characteristics and requirements.

REFERENCES

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- [2] Garcia-Zubia, J.; Orduña P. Alves, G. “Addressing sw impact in the design of remote laboratories”, *IEEE Transactions on Industrial Electronics*, Vol. 56, N°. 12, pp: 4757-4767, 2009.

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